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ABSTRACT

Cognitive psychology has replaced behaviorism as the dominant school of thought in American psychology regarding learning and development. This paper investigates changes in the field that have led to this major shift. The different methods used by behaviorists and human information processing (HIP) psychology are described. The metaphor of the human mind as a computer coupled with the central role of the computer today favors the use of an information processing model. HIP brands of cognitive psychology are compared and contrasted with the Piagetians. The types of studies and evidence that suggests that development is more domain specific than Piaget thought are discussed within the following points: (1) cognitive revolution in American psychology; (2) the HIP approach; (3) methods by behaviorists and HIP theorists; (4) Piagetians versus the HIP approach, (5) knowledge versus mind; (6) the rejection of the stage theory; (7) domain general and domain specific development. (Author/EMK)

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Learning and Cognition: The Cognitive Revolution in American Psychology

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Cognitive psychology has replaced behaviorism as the dominant school of thought in American psychology. What brought about this cognitive revolution? Why were the early leading advocators of human information processing (HIP) dissatisfied with behaviorism? Which of behaviorism's assumptions did HIP researchers reject? What evidence and arguments did they use against behaviorism? Both behaviorists and HIP researchers reject the notion of stages and why? Now there is more emphasis on learning within specific domains rather than Piaget's idea that developmental is domain general and why? HIP brands of cognitive psychology take a different view of development than do Piagetians.

Therefore, the aims of this paper are to describe the different methods used by behaviorists and HIP theorists, to compare and contrast the HIP advocators and Piagetians, and to discuss what types of studies and evidence suggest that development is more domain specific than Piaget thought, based on the following seven points: (1) cognitive revolution in American Psychology, (2) the HIP approach, (3) methods by behaviorists and HIP theorists, (4) Piagetians versus the HIP approach, (5) knowledge versus mind, (6) the rejection of the stage theory, and (7) domain general and domain specific.

Cognitive Revolution in American Psychology

Before referring to the cause of this revolution, let me touch upon the reason why the terms "behaviorism" and "learning theory" were used as if they were synonymous for many years in American psychology. This confusion is understandable, as Wingfield (1979) points out, when we trace the development of

psychology's search for an understanding of human behavior in general and human learning in particular. Early psychologists assumed that people think, have ideas and sensations, and act through the power of free will. As the psychologists observed it, their task was to catalog the nature of these ideas and sensations using introspection as a tool. Introspection became something of an art, particularly when Wilhelm Wundt (1832-1920), often regraded as the founding father of modern psychology, trained people to look inside themselves and to report their internal experiences as they thought, perceived, and learned.

John B. Watson (1878-1958), the father of behaviorism, was a vocal opponent to the use of introspection. Watson argued that the field of psychology should concentrate its efforts on the study of behavior and leave the understanding of the internal mental states. With regard to human learning, Watson asserted that the observable events will be physical stimuli which give rise to overt response. After all, behaviorism dominated scientific psychology in the United States from about 1910 to 1950 (Barasalou, 1992). After that, the attempt to understand behavior in terms of mental processes was replaced by explanations in terms of laws of learning, which concentrated on the functional relations between environmental stimuli and behavioral responses.

As Watson's behaviorism was his reaction to the earlier mentalism, so cognitive psychologists felt that the time had come to look more closely at internal events which were completely rejected by behaviorists. Bartlett and Piaget, in particular, argued that human subjects are not just passive receivers of stimuli and producers of responses. They also argued that learning is an active process which involves the use of strategies and the transformation of sensory experiences into new categories and organized conceptions. The term "cognition" began to receive wider use throughout experimental psychology and came to be used as a general

term to describe the mental processes. Human learning, engaging in active responding, organizing, and recognizing materials, almost always involves some kind of cognitive activity. Behaviorism rejected the subjective study of mental phenomena to make psychology a science and to equip it with the tools of objectivity and measurement. By the same token, cognitive psychology later rejected the narrowness of the stimulus-response view of behaviorism regarding human activities, setting as its goal a scientific study of behavior. Cognitive psychologist hope to understand and to explain the internal mental states which lie just between the stimulus and the response.

The HIP Approach

The modern era of cognitive development began in the 1960s (McShane, 1991). Two major forces have shaped modern theories of cognitive development: (1) the work and ideas of Jean Piaget (1896-1980) of Switzerland, and who was much influenced by Baldwin (1861-1934), the first major modern developmental theorist; and (2) the HIP approach which was not the product of any particular person. Notice that Barasalou (1992) recognizes computer science as the third major force that has contributed to the demise of behaviorism and the rise of cognitivism, describing that the components of cognitive theory are similar to computer components, as is their organization. In other words, the central theme that unites cognitive psychology and computer science is information processing; both disciplines focus on how systems acquire, store, retrieve, transform, and produce information to perform intelligent activities. Cognitive revolution occurred in American psychology during the 1950s and 1960; the most salient features of this new approach to psychology were the acceptance of mental processes and the representation of knowledge as necessary components in understanding human learning and the rejection of the narrow approach by behaviorists.

Who were the early leading advocates of HIP? Both John Flavell (a developmental psychologist) and Noam Chomsky (a linguist) should be named. Why were they dissatisfied with behaviorism? One of the major reasons for their dissatisfaction is, as Mackenzie (1977) has stated, that behaviorists do not share any common view on what is learned, how it is learned, or what class of theoretical conceptions is most appropriate to account for human learning. How does a child learn to think about the world, to use mathematical reasoning, and to master the syntactic structure of language? To answer these questions, it is necessary to explain what is developing and how development occurs.

Which of behaviorism's assumptions did HIP theorist reject? What evidence and arguments did they use against behaviorism? First, it is important to remember the belief of Watson that learned associations between external stimuli and observable responses are the building blocks of human development. Thus behaviorists clearly express a mechanistic world view, focusing on the way in which the stimulus-response relationship is formed; specifically, they view of learning as changes in the form or the frequency of behavior as the consequence of environmental events. HIP researchers reject this assumption; instead they argue that learning is an internal mental activity which cannot be observed directly, pointing out that the behavioral view of learning conclusively differs from the cognitive view of learning as an acquisition of knowledge and cognitive structures due to information processing. Second, it should be noted that traditionally behaviorists have characterized the organism as a *tabula rasa*, whose behavioral habits and skills primarily reflect the particular environmental events that occur in conjunction with behavior. Skinner, one of the most influential American psychologists, stresses that the essence of human development is the continual acquisition of new habits of behavior and that the learned behavior is controlled by

external stimuli (such as reinforcers and punishers). HIP rejects this assumption and argue that learning results from interaction between an environmental stimulus (the information that is to be learned) and a learner (the one who processes and transforms the information). When Skinner tried to explain language learning from a behaviorist perspective, for example, Chomsky urged that Skinner's view only considered the observable stimuli and responses in linguistic interactions and is not sufficient to account for the structural properties of human utterances (Barasalou, 1992).

Additionally, HIP theorists argue that a stimulus cannot be defined in physical terms but depends on what an organism attends to, encodes, and comprehends. Even something as simple as a flashing light, as Wingfield (1979) describes, offers numerous opportunities for interpretation; the functional stimulus could be the frequency, intensity, size, location, and the shape of the light. In addition, a learned response cannot be defined in physical terms, such as by specifying particular kinds of muscle actions (for example, rats that learn to run a maze can swim the correct path just as well, even though different movements are used). A response must be understood in terms of the knowledge acquired by the organism. The rules relating stimuli and responses are not always based on simple associations; thus direct stimulus-response associations cannot explain how a child arranges words into a sentence.

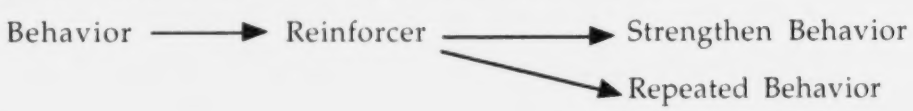
Methods by Behaviorists and HIP Theorists

What are the different methods used by behaviorists and HIP theorists? Operant conditioning should be described as a method used by behaviorists. Skinner (1976) says that human behavior is the most familiar feature of the world where people live. Skinner advanced Watson's behavioral perspective by demonstrating and then by gaining understanding of one very important form of

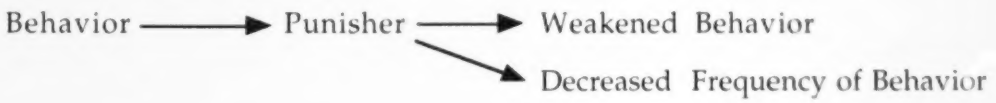
learning called "operant conditioning."

Behaviorists: Operant Conditioning. Operant conditioning, defined as learning in which voluntary behaviors are strengthened or weakened by consequences or antecedents, is that voluntary response influenced by consequences that follow. Classical Conditioning by Avion Pavlov, a Russian physiologist and psychologist, emphasizes the relationship between antecedent stimuli and responses, while operant conditioning emphasizes the relationship between responses and their consequences. All the basic principles of Pavlovian Conditioning are found in Skinner's experiment (Skinner box). A rat learned to press the bar more often when the behavior was reinforced by a food pellet. If it was not reinforced, extinction occurred. The rat generalized and pushed the bar at the same rate whether the pellet appeared or not. After selective reinforcement was repeated often enough, the rat discriminated and pushed the bar more frequently than the pellet appeared. A child tends to repeat behavior which has pleasant consequences and to cut down on behavior which has unpleasant consequences. Through operant conditioning, the child learns new skills and a range of habits. In a way, it makes sense.

Operant conditioning pairs behavior with consequence, which are only effective if they increase desired behaviors or decrease undesired behaviors. If the consequence weakens the behavior, then it is called (Type I and Type II) punishment. According to the behavioral view, consequences determine to a great extent whether a child will repeat the behavior which leads to the consequences. A reinforcer is any consequence which strengthens the behavior it follows. The reinforcement process can be simply illustrated below.

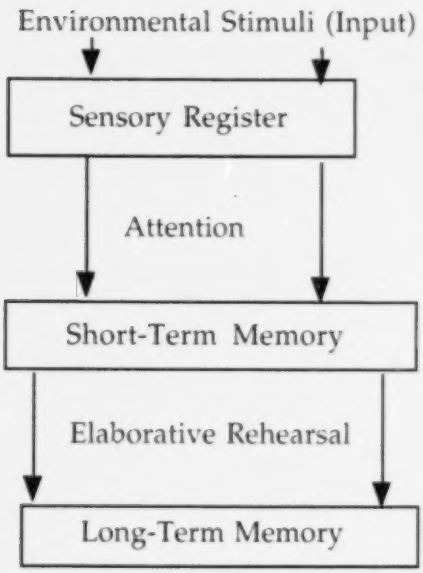


Reinforcers are those consequences which strengthen the associated behavior. There are two types of reinforcement. The first is called "positive reinforcement" which occurs when the behavior produces a new stimulus. The second one is negative reinforcement; "negative" in negative reinforcement does not imply that the behavior being reinforcement is necessarily negative. This meaning is similar to that something is subtracted. Thus associate positive and negative reinforcement occurs by adding or subtracting something following a behavior. Negative reinforcement is often confused with punishment. A behavior followed by a punisher is less likely to be repeated in similar situation in the future. The process of punishment is illustrated below.



HIP: Cognitive Model. Cognitive model (an model of information processing of learning) should be described as a method used by HIP theorists. One of the central metaphors of the information age is that human mind is a computer. In particular, computer science (and artificial intelligence) caused the reexamination of basic postulates of memory processing and storage as well as of language processing and acquisition. The HIP theories search for the ways the human mind acquires, stores, recalls, and uses information; and, these functions are very similar to the functions of computers. A poplar model of HIP does visualize three memory storages (as illustrated below) and a set of processes that determine whether and how stimuli undergo further processing. The memory system is an example of a high-level component of the HIP theory. A second characteristic of the HIP theory is an emphasis on the codes or representations used to store information.

Three Memory Storages



The first memory storage is the sensory register which holds stimuli briefly (about one to three seconds) in original form for possible future processing. The short-term memory is the second memory storage (also called working memory) which holds about seven bits of information for about twenty seconds. The long-term memory is the third memory storage (also called the permanent store house of information) which is thought to have an essentially unlimited capacity. In short, information enters the system through the sensory register, and persists there for a short time after the end of stimulation, but much never passes beyond it (Meadows, 1993). If it proceeds, information then enters short-term memory storage and passes on to long-term memory storage. Because of the limitations of the sensory register and short-term memory, some information may be lost at each point of entry. Each of the function of storages is described in more detail as follows:

Sensory Register. Sensory register is the entry point to the memory system. If younger children can not take in as much sensory information as older children, or if they can not take incertain sorts of sensory information, or if they take in sensory information more slowly, then, the sensory storage can be a cause of developmental differences in memory. Children seem to be somewhat slower than the adults in forming a sensory representation of what they see; this slower speed of taking in information may restrict learning and memory for children. The process of recognition involves nothing key features of a stimulus and relating them to already stored information. The most important point to remember is the recognition and meaningful processing of information. And the selective focusing on a portion of the information currently stored in the sensory register is what is called attention; there are individual differences in attention.

Short-Term Memory. The next source of developmental is short-term memory. Two of the most well established principles of human memory are rehearsal and organization. Rehearsal refers to the continuous repetition of what one is trying to hold in mind; elaborative rehearsal is based on organization (several items are grouped together on some basis and rehearsed as a set) and meaningfulness. Children under the age of about seven are rarely seen to use memorization strategies which would be appropriate to memory tasks. There is little spontaneous use of the simple technique of rehearsal. Where older children and adults would repeat such material as spoken words, under the age of about seven there is little rehearsal. Older children and adults are more likely to rehearse several items and to adapt their rehearsal strategy to the particular domains of the task. It is helpful for children to recognize material in categories and rehearse categorized materials. This information is

used to determine what categories are included for summary and recognize the actuarial instances involved. Young children are less likely to divide a list according to stable and helpful categories, or to search categories systematically. Young children are also less likely to use helpful elaboration techniques. Therefore, there are differences between younger and older children in terms of probability of implementing rehearsal, elaboration, and organizational strategies.

Long-Term Memory. The long-term memory does play an influential role throughout the information processing system. The interests, attitudes, skills, and knowledge of the world that reside there do influence what children perceive, how children interpret their perceptions, and whether they process information for short-term or long-term storage. Stored knowledge in the long-term memory is believed to be organized in schemata which are related to Piaget's scheme. When schemata are well formed, comprehension occurs. When schemata are poorly structured or absent, on the other hand, learning is slow and uncertain. In short, long-term memory storage and meaningfulness can be enhanced by relating what is to be learned to what is familiar to the child.

Topics of Interest: Behaviorists versus HIP. Behavioral theorists believe that cognitive processes (such as thinking and sensing) are behavioral, whereas HIP theorists believe that cognitive process is the base of behavior. The behavioral view is similar to the search for internal determinants of behavior by early Greeks, who suggested that heart, lungs, and liver are unsuccessful candidates for this search, and brain is among the latest. Behaviorists assume that the outcome of learning is change in behavior, emphasizing the effects of external events on the child. Human subjects actively "operate" on their environment to produce different kinds of

consequences. In the light of the basic principles of operant condition, behaviorists concern with the following topics: positive reinforcement, negative reinforcement, punishment, extinction (weaken undesired behavior by ignoring it), generalization (responding in similar stimuli), discrimination (responding in different ways to similar stimuli, and schedules of reinforcement (fixed interval schedule, variable interval schedule, fixed ratio schedule, and variable ratio schedule). Additionally, behavior modification is a technique of shaping behavior to reinforce desirable responses or ignore undesirable responses. Behavior modification therapy is based on the principle that behavior is learned and therefore it is possible to change almost any behavior by altering the child's environment.

The main theme of the cognitive revolution is that internal processes are the subject matter of psychology. Cognitive psychology is concerned with how human subjects acquire, transform, represent, store, and retrieve knowledge, and with how the knowledge direct what they attend to and how they respond. HIP's interest is brain-processing, focusing on the following topics: attention, memory, pattern recognition, semantic organization, images, language process, thinking, judgment, reasoning, remembering, creating, and solving problems, as well as other cognitive topics which have been once considered outside the boundary of experimental psychology. HIP researchers study the internal process using the tools of experimental psychology, in which sometimes elaborate hypothetical states are postulated; these internal processes are the matters which go on in the behaviorist's black box. Behaviorists are concerned with the response an organism makes in a certain situation but are not at all concerned with what transpires between the stimulus and the response. This mysterious absence is called "black box." In construct, cognitive psychologists draw a "white box" between the stimulus and response and then write description of what goes on inside the box.

Piagetians versus the HIP Approach

Piaget's Stage Theory. HIP brands of cognitive psychology take a different view of development than do Piagetians. Piaget presents his stage theory of development which is described below. Each stage is characterized by a particular type of cognitive structure which does play a key role in the theory. Cognitive structures, which constitute organizational principles that are inferred from the various behaviors that can be measured, have a pervasive effect on thought during the long-span of development.

Sensorymoter Stage. The first stage lasts from birth until about two years of age. Infants and children during this stage lack true thoughts and acquire understanding primarily through sensory impressions and motor activities; therefore, Piaget calls this sensorimotor stage. Because infants are unable to move around much on their own during the first months of postnatal existence, they develop schemes primarily by exploring their own bodies and senses. Children during this stage move from having only innate reflexes at the beginning to being able to represent mentally the external world. An important cognitive development milestone (object permanence) occurs between the fourth and eighth months olds. Most children under the age of two are able to use schemes they have mastered to engage in mental, as well as physical, trial and error behavior. Children under the age of two tend to imitate the behavior of people (or animals). These imitative behaviors show the children's increasing ability to think in terms of symbols. Schemata develop into mental representations when children begin to store information about the world and use that information as the basis for later behavior.

Preoperational Stage. This stage usually lasts from two years of age until seven. The thinking of preschool children (roughly two to five year-olds) centers on

mastery of symbols (such as words) which permits them to benefit much more from past experiences. Many symbols are derived from mental imitation and involve both visual images and bodily sensations; the schemes of this stage incorporate and build on the schemes of the previous stage. Even though children's thinking is more sophisticated, they are still limited in their ability to use new symbol-oriented schemes; their thinking and behavior are illogical; they form many new schemes but do not think logically. In a typical conservation experiment, a child is asked to explain what happens when water is poured back and forth between containers of different sizes and shapes. The preoperational child is unable to consider more than one feature at a time and is unable to mentally reverse the action of pouring; therefore, the child is likely to maintain that a tall container holds more water than a squat container, even if the amount is the same. When asked, "Why do you think so?," preoperational children tend to reply, "Because it's taller." Children over the age of six are more likely to reply," The taller one looks to have more water, but the amount is the same." One reason preoperational stage children have difficulty solving conservation problems is perceptual conservation. Tendency to focus attention on only one characteristic of an object or aspect of a problem or event at a time is a strong one. Young children focus only on the height of the water in the two containers and ignore the differences in width and volume. Another impediment to logical thinking is irreversibility which means that young children cannot mentally pour the water from the tall thin glass back into the short squat one (thereby proving to themselves that the glasses contain the same amount of water).

Concrete Operational Stage. This stage normally lasts from seven years of age to eleven. Through formal instruction, informal experiences, and maturation, children over the age of seven gradually become less influenced by perceptual conservation, irreversibility, and egocentrism. Schemes develop which allow

children a greater understanding of such logic-based tasks as conservation (matter is neither created nor destroyed but simply changes shape or form), class inclusion (constructing hierarchical relationships among related classes of items), and seriation (arranging items in a particular order). Operational thinking is still limited to objects that are actually present or that children have experienced concretely and directly. Also, if asked to deal with a hypothetical problem, concrete operational children are likely to be stymied. Children at the age of seven are not likely to be able to solve abstract problems by engaging in mental explorations. They usually need to manipulate concrete objects physically or to recollect specific past experiences in order to explain things to themselves and others. For these reasons, Piaget describes the stage from approximately seven to eleven years as that of concrete operation.

Formal Operational Stages. This stage lasts eleven years of age and older. When children reach the point of being able to generalize and to engage in mental trial and error by thinking up hypotheses and testing them in their heads, according to Piaget, that children have reached the stage of formal operations. The term "formal" reflects the ability to respond to the form of a problem rather than to its content and to form hypotheses. Children in this stage make a movement from an ability to think and reason about concrete visible events to an ability to think hypothetically. The cognitive structure of this stage can be particularly characterized by four rules for manipulating the content of thought: identity, negation, reciprocity, and correlativity. The formal operational thinkers, for example, can read the analogies "10 is to 30 as 1 is to 3," in addition to that they are able to deal with abstractions, form hypotheses, and engage in mental manipulations. Furthermore, formal operational thinkers are able to understand and use complex language forms, such as proverbs, metaphors, and sarcasms.

Information Processing Framework. Again, what is developing and how it occurs? These issues can be explained within the HIP framework. The central components of the framework are the innate cognitive architecture, the mechanism of learning, and the procedure and the representation that are created for information processing. HIP has become a popular approach to the study of learning. This was because the HIP approach provided psychologists with a framework for investigating the role of a learner that behaviorism had ignored (Snowman, 1991). Cognitive psychologists have come to rely more and more on ideas borrowed from the HIP approach. These ideas help to give a more exact specification of what information is relevant to perform a particular task and to explain how information is stored and manipulated by children. The HIP theory is based on the three major assumptions: (1) information is processed in steps or stages, that is, attending to a stimulus, recognizing it, transforming it into some type of mental representation; (2) there are limitations on how much information can be processed at each stage; and (3) the HIP system is interactive, that is, information already stored in memory influences and is influenced by perception and attention.

Regarding what develops in the information processing system, the HIP theory answers that the basic components do not develop because they are innate. What develops is the control process which manipulates information. For instance, strategies used by adults to process information in short-term memory are likely to be very different from the strategies used by children. The general answer to what develops provided by research into memory development, and the strategies for encoding and manipulating the information developed. A corollary of this is that the type of information stored in long-term memory will change as strategies develop. Given the same memory task, for example, a four-year-old child is likely to use different encoding strategies and thus show different recall. That is why the

HIP theory encompasses a large number of research studies in such areas as perception, attention, memory, comprehension. As children grow older, their memory space grows with them so that they become able to process more interaction at one time, improving their cognitive performance. Control processes in both short-term and long-term storages are very convincing candidates for developmental change. The main development of recognition is not in the ability to do it at all but in the complexity of what is taken in and later recognized. As children grow older they can remember more information about the stimulus and can discriminate smaller differences between the familiar stimulus and the novel one over a longer period of time. The basic structure of memory is not thought to change during childhood, although the size of the working memory storage may increase. The use of the structure and the process of memory involves strategies.

Knowledge versus Mind

In children's cognition, What develops? HIP researchers answer "knowledge," while Piagetians answer "mind." Why the different answers? Interestingly, both the Piagetian model and the HIP approach, as Meadows (1993) describes, are based on one key idea: there are psychological structures (such as operations, concepts, working memory, and intelligence) in children's minds which explain their behaviors. Psychology is the study of the individual maturation or learning, or individual construction of an internal model of outside reality, or some combination of such factors in the individual mind. Meadows (1993) recognized the work and ideas of Vygotsky of Russian (who made significant observations and proposed theories of child language development) as the third major model of cognitive development. One of major disagreements was that Piaget believed that development would proceed learning, whereas Vygotsky (1896-1934) believed that learning would proceed development.

Piagetians: Mind. Piagetians stress that learning is neither a product of language nor a product of perception; it grows instead from activity and the consequent process of self-regulation, or equilibration, that integrates both assimilation (new experience is fitted into existing scheme) and accommodation (scheme is created or revised to fit new experience) as well as the various subsystems of the organism. Learning results from contradictions that lead to states of disequilibrium. Piaget was the one who observed unexpected and unknown facets of child thought and behavior more than anybody else did. And he proposed that children pose inherent desires to maintain a sense of organization and balance on their conceptions of the world. For Piaget, scheme is organized pattern of behavior or thought, and his basic principles of cognitive development involve organization (tendency to combine mental processes into more general systems), adaptation (tendency to adjust to environment), and equilibration (tendency to organize schemes for better understanding of experiences). These principles are important for children to learn. In organization tendencies, for instance, children think of "cats" and "dogs" as subcategories of the more general category "animals."

HIP: Knowledge. HIP theories have been much concerned with studying the difference between a skilled expert and a novice performing the same task (for example, expert chess players see configurations and familiar patterns of pieces on the board, while poor players see individual pieces). As children learn a skill, they acquire and store increasingly complex knowledge about the skill. As Chi (1978) has stated, there is a considerable difference in the knowledge that the expert and the novice posses, and this difference will affect such factors as how a task is approached and what information is sought. For the HIP researchers, children are regarded as universal novices on tasks. Chi (1978) recognizes strategies, knowledge, and capacity as influential factors in memory development: in a study regarding the chess

tournaments, Chi stresses that the amount of knowledge of an individual possess about a specific content area can determine to a large extent how well the individual can perform in both memory and metamemory tasks. Chi also stresses that older children are adept at acquiring and using strategies to cope with memory tasks; thus compared to younger children, older children and adults are better predictors of their own memory performance because they can judge the usefulness of certain strategies for a task. Knowledge affects development through the growth of the knowledge base, and the adults have a richer knowledge base than do children.

Challenge to Piaget's Ideas. It is generally agreed now that babies are smarter than Piaget thought and most adults don't function at the level of formal thought. What types of evidence lead to these criticisms? Piaget theorized that children in the stage of sensomorimotor stage cannot think, although they can learn to do simple things (such as crawl and recognize common objects). Other researchers, including Jean Mondler, suggest that the development of conceptual knowledge of infants is far more extensive than Piaget thought. In an experiment, infants preferred to view the film that matched the sound. Another evidence is that even infants only one month old seem to be able to recognize objects only felt in their mouths. These suggest that infants may possess sophisticated logical operations far earlier than thought by Piaget. McShane (1991) has reported a study regarding trained six-month-old infants, who discriminated the /a/ and /i/ vowels produced by a male speaker. Generalization of the discrimination was tested for novel stimuli produced by women and child speakers. The level of performance for all children was extremely high and for many it was near perfect. For Piaget, formal-operational thought marks the end of intellectual growth. As Snowman (1991) indicates, adolescents sometimes deal with mental abstractions representing concrete object, and most twelve-year-old children solve problems haphazardly, using trial and

error. It is not until the end of the high school years that adolescents are likely to attack a problem by forming hypotheses, mentally sorting out solutions, and systematically testing the most promising leads.

The Rejection of the Stage Theory

Both behaviorists and HIP researchers reject the notion of stages and why? One of the reasons for the rejection by HIP comes from the concept of metacognition, which was proposed by Flavell (1976) to explain why children of different ages deal with learning tasks in different ways (Snowman, 1991). The HIP researchers, such as Flavell, explain as follows: for example, when seven-year-old children are taught how to use both a less effective technique (simple repetition) to remember pairs of nouns and a more effective technique (imagining the members of each pair doing something together), most of them are likely to use the less effective strategy when given a new set of pairs to learn. Most ten-year-old children, however, are likely to use the more effective strategy. This explanation implies that the seven-year-old children has not had enough learning experiences to recognize that some problems-solving strategies are better than others. This lack of metacognitive knowledge makes true strategic learning impossible for young children. Metacognition covers everything children can know that relates to how information is processed. For HIP researcher, the candidates of their search for "what develops" are basic capacities, strategies, metacognition, the knowledge base.

On the other hand, behaviorism is closely associated with the stimulus-response psychology. For classical behaviorists, the structure of cognition was an associative chain of mediating responses. As the content of associations is entirely the product of learning, the structure of cognition is thus entirely the product of learning. Behaviorists assume that the outcome of learning is change in behavior, and they emphasize the effects of external evens on human subjects. In addition,

behaviorists stress that children are motivated when their behaviors are reinforced by being promised praise or rewards (extrinsic forms of motivation). Skinner demonstrated that organisms tend to repeat actions that are reinforced and that behavior can be shaped by reinforcement; and, Skinner developed the technique of programmed instruction (teaching machines) to make it possible for children to be reinforced for every correct response. Supplying the correct answer, teachers can motivate children to go on to the next step. For behaviorists, the specification of laws relating observable stimuli to measurable responses is sufficient for human learning.

Domain General and Domain Specific

Now there is more emphasis on learning within specific domains rather than piaget's idea that development is domain general and why? One of the reasons is, as Wood (1988) describes, that viewing the process of learning as the acquisition of expertise helps us to identify very specific processes, which are implicated in skillful thinking and problem-solving. In company with today's children of learning and cognition, it has been argued that Piaget's account of rational thought, couched in terms of logical operations, does not provide an adequate description of what children do as they think, reason, and solve problems. More attention should be given to the task-specific analyses for understanding as to what a particular child can and cannot do in a certain given learning situation. Furthermore, human mind has been conceived of as a system which represents information as symbols. The mind then processes the symbols in a serial fashion according to rules for their manipulation and stores the results in localized slots in long-term memory. As Davis and Cochran (1990) describe, the model of HIP works particularly well for tasks which require conscious effort and thought (such as chess). A good deal of attention has been directed toward applying HIP to the skills of writing, reading

comprehension, mathematical reasoning, and language structures.

More domain specific than Piagetians. What types of studies and evidence suggest that development is more domain specific than piaget thought? Davis and Cochran (1990) indicate the following educational implications: (1) a child must employ many different and complex information processes in acquiring the skills of reading, writing, and mathematics; (2) different processes assume greater importance at different stages of acquisition (e.g., decoding processes are more critical during the early stage of learning to read, and comprehension processes are more important during later stages), and (3) children learn to cope with the problem of limited attentional resources (this is done by reaching a stage of automatization on a subordinate process [decoding] and thereby free attentional resources for other super ordinate processes [comprehension]), and dealing with the problem of limited attentional resources is to learn a strategy [chunking] which reduces the processing demands of a task. Encoding differences could be accommodated by providing the field-dependent children ample time and practice to develop automaticity on basic processes which are prerequisite to a more complex process. Long-term memory difference could be accommodated by providing field-dependent children organizational aids, such as outlines and objectives.

It should be noted that most children know very little about the role their own capabilities playing in learning. One way to grasp the essence of metacognition is to contrast it with cognition, using learning tactics effectively. There are clear developmental differences in how well children understand the need to tailor learning tactics to task demands. School teachers can help children develop strategies (general plan to achieve a long-term plan) and learning tactics (specific technique, such as rehearsal, and mnemonic devices). Field-independent children are presumed to rely on internal cues, it would be reasonable to hypothesize that the

field-independent children develop the metacogntive skills earlier and more efficiently than field-dependent children.

Piagetians thought that children not only learn responses or actions but also construct operations, but Chomsky thought that language cannot profitably be viewed as vocal responses to stimuli (language involves a system of grammatical rules). Piaget's theory predicts that the use and the understanding of language is constrained by stages of intellectual development. Chomsky argued that language has a special structure which involves systems of specifically linguistic rules that cannot be reduced to cognition. Piaget viewed that schemes would evolve through four stages of cognitive development. Chomskians argued that the course of specifically linguistic development, like the child's use and understanding of grammar, could not be understood simply in terms of stages of intellectual development nor in terms of communication skills. The child, in this view, does possess a natural capacity to discover how language is structured. Language development is a special affair and cannot explained in terms of the child's general knowledge of the world. Finally, in the light of the higher-order cognition, studies on knowledge structure and memory will be the indications of domain specific strategies. Chi's study is a good example; in fact, Chi suggests that it may be necessary to introduce a subclass of general strategies which can be called "task-specific strategies."

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